Effects of Sentence Processing Strategy Proximity on the Comprehension of Second Languages

第二言語理解における文理解方略類似性とその影響について

Hiroko YAMASHITA
山下 裕子

Rochester Institute of Technology
ロチェスター工科大学

Abstract

The current study examines how similarities in sentence processing strategies between a speaker's L1 affect his understanding of L2. The comprehension of Japanese by speakers of Chinese, Korean, and English is compared. The results demonstrate that with the same methods of instruction and amount of practice, comprehension accuracy overall ranked according to the degree of proximity in sentence processing strategies. Furthermore, the decline in accuracy and the use of foreign cues as the complexity of sentences increased was most notable in the most distant languages compared. The results suggest that speakers of more psycholinguistically distant languages may require more processing resources than speakers of closer languages in the sentence processing of the L2s.

1 Introduction

In studying foreign languages, it is often felt that some languages are easier to learn than others. There are presumably many possible reasons for this. When learning a language
within the same language family, such as Italian speakers learning Spanish, similarities in orthography, lexicon, word-order, and grammatical concepts such as gender may facilitate the learning of the target language. Even without lexical or orthographic similarities, however, learners appear to benefit from learning languages that share similar linguistic aspects such as word-order. One example is Korean speakers learning Japanese. Despite differences in orthography and cognates limited to Sino-origin content words, they are notably faster than speakers of English at acquiring Japanese reading and speaking skills.

Where exactly does this advantage come from? In the field of second language acquisition, characteristics of the grammar of the learner's native language (hereafter L1) have often been thought to account for the difficulty in learning the second language (hereafter L2) as suggested in studies based on the Contrastive Analysis (e.g., Lado, 1957, 1971) and those based on the Competition Model (e.g., Bates and MacWhinney, 1981, 1982). However, the relation between L1 grammar and L2 learning has not been well explored from the psycholinguistic point of view, that is, how similar the learner's L1 processing strategy is to the processing of L2. Successful comprehension of L2 sentences without doubt affects learners in every facet of instruction, ranging from the introduction of the structure, to understanding the structure and producing the structure for a successful output. If the processing of L2 is similar to the learner's way of processing L1, then a speaker of such language might be advantaged over those whose native language processing strategy is different from that of L2. The current study is the first to examine if the comprehension of L2 is indeed affected by the similarity (proximity) of L1 and L2 sentence processing strategies.

2 Transfer of the use of cues and sentence processing strategies

Studies in second language acquisition demonstrate that the learner's knowledge in his L1 may be transferred (e.g., Gass and Selinker, 1983; Odlin, 1989). For instance, it has been reported that learners' morphological and orthographic characteristics in their L1 affect their comprehension of the L2 (e.g., Koda, 1988, 1990, 2000). Studies based on the Competition Model (Bates and MacWhinney, 1981, 1982) found that at the sentence level some language-specific linguistic information used in comprehension, i.e., cues, is transferred when learners attempt to comprehend the L2. The model hypothesizes that in the course of learning their L1, children learn the cues that are critical in comprehending the language as well as the relative strength of said cues, through statistical and functional experience. Experimental studies report that these strategies in L1 are transferred to L2. For instance, Su (2001) and Li, Bates, Liu and MacWhinney
(1992) observed that Mandarin Chinese speakers efficiently use semantic cues (animacy) in reading Chinese, and that they transfer this strategy to reading English as well. Similarly, it was observed that English speakers rely heavily on the position of a word in a sentence when reading English (Harrington, 1987), and the same strategy was observed in English speakers reading Chinese (MacWhinney, Bates, and Kliegl, 1984; Su, 2001).

According to the Competition Model, acquisition of a second language starts with the learner's L1-based interpretation of L2 grammar (e.g., MacWhinney, 1992). If this is the case, in addition to these processing cues, it is possible that the "sentence processing strategies" demonstrated in sentence processing studies (e.g., Frazier and Fodor, 1978; Kimball, 1973) also transfer. Sentence processing strategies are ways to effectively extract meaning from a string of words using the grammar of the language. Mazuka (1998) claims that a child learns such strategies in the course of acquiring a native language. These strategies include the productive use of linguistic information to anticipate the forthcoming structure of a sentence (Garnsey, Perlmutter, Meyers, and Lotocky, 1997; Kamide and Mitchell, 1999; Trueswell, Tanenhaus, and Kello, 1993; Yamashita, 1994, 1997), locating the syntactic heads and assigning thematic roles, as well as working with limited processing resources (Babyonyshev and Gibson, 1999; Gibson, 1998, 2000). If a learner’s L1 processing strategies transfer when s/he learns an L2 that requires different (or sometimes the opposite) sentence processing strategies, this may cause difficulties. The following sections highlight some of the consequences of such a transfer to L2.

3 Language-specific sentence processing and the consequence of their transfer

3.1 Predicting forthcoming structures: Verb information and case markers
Sentence processing studies have found that instead of waiting until the end of a sentence, a reader starts a hypothesizing in the middle of a sentence about how it will unfold. Native speakers of English were found to use verb information such as subcategorization, the type of complement(s) the verb takes (e.g., Boland and Tanenhaus, 1990; Garnsey, et al., 1997; Trueswell, et al., 1993). For example, the matrix verb in (1), “argue,” takes either a direct object or a sentential complement, but more frequently takes the latter. On the other hand, with a verb such as “discover” in (2), sentences tend to end with a direct object as in (2a) rather than with a sentential complement as in (2b). Garnsey, et al. (1997) show while reading the italicized portion of (1), whose final structure is ambiguous between (1a) and (1b), readers tend to expect
(1b) as the probable continuation while reverse tendency was observed in (2). This shows that native speakers of English utilize verb subcategorizations and their relative frequency information as they read each sentence to speculate as to how it will unfold.

(1) *The divorce lawyer argued the issue*…
   a. The divorce lawyer argued the issue.
   b. The divorce lawyer argued the issue was irrelevant to the case.

(2) *The scuba diver discovered the wreck*…
   a. The scuba diver discovered the wreck.
   b. The scuba diver discovered the wreck was caused by a collision.

Verbs in all languages play a central role in comprehension, but how the information is utilized depends on where in a sentence a reader expects the information. In an SOV language such as Japanese or Korean, verb information is not available until the end of a clause and cannot be productively used as a source of information to predict the forthcoming structure within a sentence. Instead studies have found that when native speakers of Japanese and Korean comprehend a sentence in their native language, they aggressively use information other than the verb, such as case marker information, to anticipate the forthcoming structure of a sentence (Kim, 1999; Yamashita, 1994, 1997). When English speakers learn a language where verb information is not productively used, such as Japanese, they may still rely on the verb information, which only becomes available at the end of a clause, and furthermore may not fully utilize other sources of information, such as case markers. Such misplacement of attention may cause difficulty for English speakers in comprehending Japanese.

3.2 Location of the relative head

Syntactic heads, such as the verb and the relative head noun, have been found to play a critical role in sentence processing (e.g., Ferreira and Henderson, 1995), because they receive or give thematic roles. Verbs assign thematic roles to their arguments. The relative head noun receives its thematic role from the matrix verb. Therefore, detecting the presence of the relative clause and locating the relative head noun phrase are critical in processing the sentence accurately. Compare the difference in relative clause structures in English and Japanese.¹

¹ The term relative clauses in this paper in all languages are used in the sense of a clausal modifiers.
The English relative head noun phrase shown in (3) occurs before the relative clause. Because the relative clause is the object of the matrix sentence, the head noun phrase appears immediately after the matrix verb. In contrast, a Japanese equivalent shown in (4) has the head noun phrase after the relative clause. In order to comprehend both types of sentences, the reader/listener must know when to expect the relative head noun. Since the processing of sentences with an embedded clause - such as a relative clause or sentential complement - requires an added processing load, knowing where to expect the head is critical to the successful interpretation of the sentence. When speakers of a head-initial language such as English read a head-final language like Japanese, the expectation of the placement of the relative head may transfer. At early stage of L2 acquisition, English speakers attempting to comprehend a relative clause in Japanese may wrongly interpret the first noun, *doresu* "the dress," as a head noun and thus assign the theme thematic role to it instead of *onnanoko,* "the girl," leading to an unsuccessful interpretation. Alternatively, English speakers may be forced to change their expectation of the head consciously when they read Japanese, which may add extra effort or sometimes cause a breakdown in processing.

3.3 Embeddings and processing load

A series of studies by Gibson and his colleagues (e.g., Gibson, 1998, 2000; Babyonyshev and Gibson, 1999) demonstrate that processing resources are used for the temporal storage of linguistic information and for computing newly available information in the comprehension of a language. They claim that before the verb appears, readers must keep arguments that are not yet assigned a thematic role in a memory buffer, an operation that consumes processing resources. When readers encounter the verb, thematic roles are assigned to those arguments, and the processing load used to store the arguments is consequently freed. Gibson (1998) argues that the processing resources become overloaded when readers read some double- or triple-center-embedded sentences, because in reading these sentences many arguments that are unassigned of thematic roles must be kept in buffer. Readers find those sentences incomprehensible despite the fact that they are grammatical.

It is easy to imagine that L2 learners' limited experience with the target language's different word-order or location of the relative head may cause difficulties, since
complex structures include multiple verbs and their arguments. Even if the learners have learned the grammar of complex structures, they may not be able to use this information correctly due to the extra processing resources required; thus they may have difficulty in correctly identifying the arguments to which the verb assigns thematic roles. Such a difficulty may be amplified if arguments and verbs are positioned differently from a speaker's L1, leading to a processing breakdown more easily than for learners whose language is closer.

4 Language proximity measured by native language processing

If some of the sentence processing strategies are transferred, the comprehension of sentences in L2 should be affected by it. Furthermore, the bigger the differences between the sentence processing strategies of L1 and L2, the more difficult the comprehension of L2 should be. The current study tests these hypotheses by comparing the reading comprehension of Japanese sentences by speakers of Korean, Chinese, and English. These speaker groups were chosen because they differ in proximity to Japanese in terms of sentence processing strategies, mainly, head position, basic word order (position of verb), and existence of case markers. The sentences with relative clauses below highlight the differences in processing related grammatical features.

(5) Japanese

John-wa [[hon-o ka -tta] seeto]-o mi-ta.
John-TOP book-ACC buy-past student-ACC see-past-plain

“John saw the girl who bought the book.”

(6) Korean

John-TOP book-AACC buy -past student-AACC see-past-plain

(7) Chinese

John kan-le [[mai-le shu] de xuesheng].
John see-past buy-past book rel mkr student

(8) English

John saw [the student [who bought the book]].

With respect to these sets of features, Korean is the closest to Japanese because it has the same relative head position and basic word-order as Japanese. It also has a case marking system parallel to Japanese, that is, where a particle is attached to a noun phrase or postpositional phrase to indicate the case and grammatical relations (subject,
object) assigned to the noun. Among the three languages, English has the fewest processing-related features in common. English word-order is SVO, and the relative head comes before the relative clause. Furthermore, the case marking system is mostly limited to pronouns and genitives. Chinese is intermediate in proximity between Korean and English, because its relative head position is the same as Japanese yet the basic word-order in Chinese is SVO and it lacks a case marking system. To speakers of English and Chinese, case particles are the foreign cue that they must learn in order to comprehend Japanese. These features, of course, do not exhaust all related features. Only the most relevant grammatical features are highlighted here and tested in the current study. Table 1 summarizes those grammatical features that drive the processing of each language.

Table 1. Common processing-related grammatical features of Korean, Chinese, and English in comparison to Japanese

<table>
<thead>
<tr>
<th>Language</th>
<th>Relative Head Position</th>
<th>Basic Word order</th>
<th>Case Marking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Korean</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Chinese</td>
<td>O</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>English</td>
<td>X</td>
<td>X</td>
<td>Δ</td>
</tr>
</tbody>
</table>

Note.  
O : same as Japanese  
Δ : limited similarity to Japanese  
X : different from Japanese or nonexistent in the language

All three experiments in the current study employed the task of written questionnaire-style reading comprehension. The participants were asked to read a sentence and perform tasks such as answering comprehension questions or making judgments on the naturalness or grammaticality of a sentence. This method enables researchers to control the syntactic and semantic factors the participants read, as well as the amount of time spent and the method of evaluation. It enables us to examine the interactions between different levels of sentence complexity and the depth of comprehension.

2 One factor that is not controlled in the current study is the native use of Chinese characters. Although some characters are not common to Japan, China and Korea, due to different ways of simplifications, some characters may share the same meaning in three languages. Thus Chinese and Korean speakers may have advantages from the ease of meaning recognition in reading study. In this study, we found effects based on the grammatical structure and cannot be solely explained by the orthographic similarities. However it is important to examine the current hypothesis without the effect of orthography. See section six for more discussion.
The study asks speakers of three languages to read and comprehend different types of sentences in Japanese: simplex sentences, that is, sentences with no embedding (Experiment 1); sentences with a relative clause at the sentence-initial position (Experiment 2); and sentences where the relative clause is center-embedded (Experiment 3). These structures differ in terms of their required processing resources. A simplex sentence requires the least processing resources, while sentences with relative clauses require additional processing resources (e.g., Gibson, 1998). Sentences with a center-embedded clause demand the most processing resources because they force the reader to compute a part of a matrix clause while they comprehend a subordinate clause simultaneously. By varying the types of sentences according to the processing resources they require, we will examine whether increased processing resources limit the use of the mastered grammar.

All three experiments were included in one questionnaire and all subjects finished all three experiments during the same fifty-minute session. All the subjects in the current study participated in all three experiments.

5 Experiment 1: Simplex sentences

Experiment 1 investigated the comprehension of simplex sentences in canonical/non-canonical word-orders in Japanese. It examined whether the three groups of learners successfully utilized information from case markers and semantic (animacy) advantages in comprehension. At the same time, this experiment aimed to confirm whether the subjects in all three groups have a basic mastery of Japanese grammar. It also examined the predictions in the Competition Model using a different paradigm.

The sample stimuli for Experiment 1 are shown in Table 2. The sentences compared are both canonical and noncanonical sentences with a transitive verb. Japanese allows the subject and object to scramble without altering the semantic content. Thus both the canonical and noncanonical sentences in Table 2 are semantically equivalent, with the only difference being the order of the subject and object. The subject of a sentence is marked by the nominative case marker ga, and the object by accusative marker o. Among each syntactic type, there were all-animate conditions, in which both subject and object were animate (a person), and object-inanimate conditions, where the subject was animate but the object was inanimate.
Table 2. Sample sentences representing each condition for Experiment 1

<table>
<thead>
<tr>
<th></th>
<th>Canonical (ga-o order)</th>
<th>Noncanonical (o-ga order)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All animate</strong></td>
<td>Sensee-ga gakusee-o</td>
<td>Gakusee-o sensee-ga</td>
</tr>
<tr>
<td></td>
<td>teacher-NOM student-ACC</td>
<td>student-ACC teacher-NOM</td>
</tr>
<tr>
<td></td>
<td>matte imasu.</td>
<td>matte imasu.</td>
</tr>
<tr>
<td></td>
<td>is waiting</td>
<td>is waiting</td>
</tr>
<tr>
<td></td>
<td>“The teacher is waiting for the student.”</td>
<td>“The teacher is waiting for the student.”</td>
</tr>
<tr>
<td><strong>Inanimate Object</strong></td>
<td>Onnanohito-ga sinbun-o</td>
<td>Sinbun-o onnanohito-ga</td>
</tr>
<tr>
<td></td>
<td>woman-NOM newspaper-ACC</td>
<td>newspaper-ACC woman-NOM</td>
</tr>
<tr>
<td></td>
<td>yonde imasu.</td>
<td>yonde imasu.</td>
</tr>
<tr>
<td></td>
<td>is reading</td>
<td>is reading</td>
</tr>
<tr>
<td></td>
<td>“The woman is reading the newspaper.”</td>
<td>“The woman is reading the newspaper.”</td>
</tr>
</tbody>
</table>

5.1 Hypothesis and Predictions

If all speakers fully used their knowledge of Japanese grammar, including its flexible word-order, when to expect the verb, and case marking information, then we would expect to find no difference in the proportion of correct answers between canonical and noncanonical sentences. Furthermore, all speakers would answer most of the questions accurately. On the other hand, if the L1 processing cues and sentence processing strategies transfer, we would expect to find Japanese sentences processed with each speaker’s L1 strategies. To Chinese and English speakers, the position of the verb is different from their L1. Thus their accuracy rate may be lower than that of Korean speakers. To the speakers of English and Chinese, the verb position of Japanese, which is at the sentence-final position, may be further disadvantageous. They expect how the rest of the sentence after the verb unfolds based on the frequency of the occurrence of each subcategorization type of the verb; yet the information is not available until the end of the sentence in Japanese. Particularly to English speakers, who rely on the word position in a sentence (e.g., MacWhinney, Bates, and Kiel, 1984), such change in the verb may cause difficulty. The Competition Model also predicts differences by language groups, particularly in the use of case markers and semantic information (animacy). To Chinese speakers, the concept of case marking is what they have newly learned, a foreign cue. To the English speakers, because their case manifestation is limited to
pronouns and also bound to each syntactic position, the use of case markers as in Japanese is also foreign. Thus they may have higher errors in noncanonical conditions if they do not use the case marking information appropriately. Also, according to the Competition Model, English speakers rely on word-position cues (e.g., MacWhinney, Bates, and Kiel, 1984), thus they might mistakenly treat the object in the sentence-initial position in the noncanonical condition as a subject. Chinese speakers, who are reported to rely on semantic cues (the animacy of the subjects and objects), might find the all-animate conditions more difficult to comprehend than inanimate object conditions.

5.2 Method
5.2.1 Participants
A total of thirty-six college undergraduate students at University of Illinois Urbana-Champaign, twelve each of Mandarin Chinese speakers, Korean speakers, and American English speakers, participated in the study. All speaker groups had started learning Japanese at the same time and were at the beginning level (160 hours of instruction) when they participated in the experiment. They were taught Japanese in the similar fashion for exactly the same set of instructional materials, and followed the same instructional schedule: they all used Introduction to Modern Japanese (Mizutani and Mizutani, 1977) and the workbook that accompany it. All speakers were taught in six different classes, but the classes were conducted in the same manner. They learned the grammar in each chapter through a lecture conducted in English, and they practiced the structures through both oral and written exercises in classroom activities conducted only in Japanese. There was no significant difference among the groups in the final grade assigned to this course, indicating that no group was academically advantaged over the others (F(2, 70)=1.54, p<.05).

By the time they participated in the experiment, they had all mastered the use of the Japanese writing system using all three types of orthography: Hiragana, Katakana, and some Kanji for written communication. They had all learned relative clause and subordinate clause structures about five months prior to the study and were given practice through both oral and written exercises. All showed a basic understanding of relative clauses through speaking activities in class. From the first month of instruction, they had been taught the various word-orders that are possible in Japanese sentences, including that of simplex sentences and relative clauses.

5.2.2 Materials
There were twelve sets of sentences that represented events unrelated to one another for each condition. All sentences were composed of words the subjects knew well. Of those twelve sets, six had subject and object NPs that were animate, and the other six
had an inanimate object. Within each set of sentences (i.e., six all-animate and six inanimate object), half the sentences were in canonical order and the other half scrambled. Two lists were generated, so that each participant saw each sentence either in canonical or noncanonical order. The sentences were randomly embedded along with thirty-six filler sentences, to prevent the subjects from realizing the purpose of the experiment. Filler sentences included approximately half simplex sentences, and half sentences with sentential complements. The fillers did not have the same syntactic structure as those in Experiment 1, nor any in the Experiment 2 and 3.

5.2.3 Task
Subjects were given a booklet that contained sentences written in Japanese orthography. Each sentence was followed by a task question. Test (target) sentences, which were embedded among filler sentences, were followed by a sentence soliciting subjects to describe (translate) the event in English. Participants were asked to read the sentence and complete the description in writing within 25 seconds. All participants worked on the same question, and they were not allowed to go back to change their answers.

5.2.4 Coding
Since we are mainly interested in the correct identification of subject and object, an answer was counted as accurate as long as the thematic relations of the subject and object were correct, and the verb was a transitive verb that assigned the agent and patient thematic roles. An error in the verb tense, that is, an answer in present tense instead of past tense, was counted as accurate as long as the answer reflected thematic information and verb classification.

5.3 Results
The proportion of accurate answers according to language is shown in Table 3. All groups answered with more than eighty percent accuracy. There was a main effect of animacy, $F(1, 35)=7.29, p<.01$. Animate-inanimate conditions were understood more accurately than all-animate conditions. Also observed was a main effect of word-order, $F(1, 35)=2.59, p<.05$. Canonical sentences were comprehended better than noncanonical sentences. A 2x2x3 ANOVA of animacy, word-order, and language groups revealed that there was a main effect of language group, $F(2, 70)=4.17, p<.01$. Fisher’s PLSD post-hoc showed that Chinese speakers answered less accurately than Korean speakers ($p<.05$). No significant difference was observed between Korean and English speakers. Neither the interaction between the language groups and animacy, nor between language groups and word-order was significant ($p>.05$).
Table 3. Mean proportion of correct answers by language in Experiment 1

<table>
<thead>
<tr>
<th>Language</th>
<th>All Animate</th>
<th></th>
<th></th>
<th>Object Inanimate</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Canonical</td>
<td>Noncanonical</td>
<td>Canonical</td>
<td>Noncanonical</td>
<td></td>
</tr>
<tr>
<td>Korean</td>
<td>94 (.132)</td>
<td>92 (.154)</td>
<td>97 (.098)</td>
<td>97 (.098)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese</td>
<td>82 (.362)</td>
<td>61 (.344)</td>
<td>97 (.098)</td>
<td>86 (.225)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>English</td>
<td>86 (.266)</td>
<td>80 (.333)</td>
<td>94 (.193)</td>
<td>86 (.301)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Within each group of speakers, Chinese speakers understood noncanonical orders less accurately than canonical orders, F(1, 35)=6.57, \( p<.05 \). No effect of word-order was observed in the accuracy within the group of English speakers nor Korean speakers. Also within each group of speakers, the Chinese speakers responded to all-animate sentences less accurately than object-inanimate sentences, F(1, 35)=11.99, \( p<.01 \). English and Korean speakers did not answer animate/inanimate sentences differently (\( p>.05 \)).

5.4 Discussion

The results show that the participants comprehended the simplex sentences quite accurately despite the difference in sentence processing proximity: speakers of all three languages answered with more than eighty percent accuracy overall. The results do not show any interaction between language groups and animacy, nor between language groups and word-order, as predicted by the Competition Model. The model would predict Chinese speakers would be more sensitive to semantic (animacy) information, whereas English speakers would be more sensitive to word-order. While the English speakers comprehended the sentences well despite the fact that the word-order and the position of the verb were different from their L1, Chinese speakers did show the trend predicted by the Competition Model. They answered slightly less accurately when the sentence was in noncanonical order, indicating that the first noun was interpreted as a subject. However, overall the difference was not large enough to be detected as statistical interaction.

In Experiment 1, speakers overall accurately comprehended simplex sentences regardless of their L1, with slight advantage of animacy information and canonical word-order. We will now examine how the three groups comprehended a more complex sentence structure that is more demanding in its processing load requirements.
6 Experiment 2: Relative clause in subject position

Experiment 2 examined the comprehension of sentences whose subjects are "heavy," that is, a noun modified by a relative clause. Two types of stimuli sentences containing two kinds of relative clauses were created: those with subject relativization, and those with object relativization. In each case the relative clauses were the subject of a main clause. This type of sentence is more demanding in processing, and thus requires a higher processing load (e.g., Babyonyshev and Gibson, 1999; Gibson, 1998). These sentences should therefore allow us to observe how accurately speakers whose language differs in processing proximity to Japanese comprehend when their processing resources are heavily consumed. If the processing strategy of L1 transfers, we would expect that more errors in interpretation is observed as a consequence of incorrectly locating arguments and relative heads.

Experiment 2 employed the following stimuli. ‘A’ stands for animate argument, ‘I’ for inanimate argument, Vt for transitive verb, Vi for intransitive verb, and e for the intended gap coindexed with the relative head.

Table 4. Sample sentences and multiple-choice answers representing each condition for Experiment 2

<table>
<thead>
<tr>
<th>Condition</th>
<th>Example Sentence and Multiple-choice answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject Relativization</td>
<td>[[Sensee-o mita] [gakusee]-ga kaerimasita. Teacher-ACC saw student-NOM went home “The student that saw the teacher went home.”]</td>
</tr>
<tr>
<td></td>
<td>a. correct answer: The student went home.</td>
</tr>
<tr>
<td></td>
<td>b. wrong subject answer: The teacher went home.</td>
</tr>
<tr>
<td></td>
<td>c. wrong answer: The teacher saw the student.</td>
</tr>
<tr>
<td>Object Relativization</td>
<td>[[Sensee-ga mita] [gakusee]-ga kaerimasita. Teacher-Nom saw student-NOM went home “The student that the teacher saw went home.”]</td>
</tr>
<tr>
<td></td>
<td>a. correct answer: The student went home.</td>
</tr>
<tr>
<td></td>
<td>b. wrong subject answer: The teacher went home.</td>
</tr>
<tr>
<td></td>
<td>c. wrong answer: The student saw the teacher.</td>
</tr>
</tbody>
</table>

Japanese relative clauses are constructed with the head noun (gakusee “student” in the example) immediately following a relative clause that ends with a verb in a direct form
Furthermore, there is no morphological marking on the verb that signals that the clause up to that point, sensee-ga mita “the teacher saw,” is a relative one. Thus Japanese relative clauses are always ambiguous between a simplex sentence and a relative clause, and readers cannot disambiguate the structure (i.e., determine which is the correct interpretation), until the head noun appears. For learners of Japanese as an L2, therefore, interpreting the sentences in the subject relativization condition involves (1) identifying the structure as a sentence with a relative clause, (2) identifying the relative head and relative clause it is modified by, (3) identifying that the first verb they see is a part of a relative clause, not a matrix verb, and (4) correctly assigning the thematic roles of the two verbs to appropriate arguments. From the relative verb, the <Agent> role to the subject of the relative clause and the <Patient> role to the object of the relative clause; and from the matrix verb, the <Agent> role is assigned to the matrix subject, which is the relative clause. Readers are asked to choose one of the answers for the comprehension questions. Choosing the correct answer beyond chance likely entails that all these processes have been completed successfully. Choosing one of the other two incorrect answers perhaps signals that some of these processing steps were not followed.

6.1 Hypothesis and predictions

If speakers in all three groups used knowledge of the typical relative clause structure and the processing strategies of Japanese relative clause structures, such as case marking and thematic role assignments to appropriate heads, we would expect no difference in the proportion of correct answers among speaker groups. On the other hand, if the effects of their L1 sentence processing strategies manifest, then the proportion of correct interpretations would reflect the processing proximity between Japanese and each subject's native language: Korean speakers would comprehend the sentences best, because the location of their arguments, verb, and the head noun is analogous to Japanese. Furthermore as shown in Table 1, Korean shares the most similarities with Japanese among the grammatical features that are relevant in processing these sentences: relative head position, case marking, and word-order. By contrast, English has the fewest features in common, for the relative head in English is the opposite of Japanese, in addition to the lack of productive use of case markings. English word-order, including the order of matrix and subordinate verbs, is also opposite. In English, the first word tends to be the subject of the matrix clause, and the first verb that immediately follows it is the matrix verb. In the stimuli of the current experiment, the first verb is the verb of the subordinate clause, and the first noun belongs to the embedded clause. In order for the English speakers to comprehend these
sentences, they need to ignore their L1 knowledge and use the word order in Japanese. Thus we predict that English speakers would comprehend the sentences least accurately. Chinese falls between Korean and English, since it shares the same head direction in the relative clause, but differs from Japanese in the word-order of this structure. Because the canonical word-order of Chinese is SVO, the first word in L1 in Chinese is typically a subject of the matrix clause, and the first verb is usually the matrix verb. In order for the Chinese speakers to comprehend this sentence, they need to realize that the first clause in both types of stimuli is a part of the relative clause. Thus we predict that Chinese speakers would perform with the accuracy between Korean and English speakers.

The participants must choose a sentence describing an event. Critically, in two types of incorrect answers, choosing the wrong subject answer reveals the lack of the use of case markers. Notice that the first noun, sensee “the teacher,” is marked by an accusative marker o in the subject relativization condition. Thus it is very unlikely that the noun is the subject of the matrix clause. On the other hand, the same first noun in the object relativization condition is marked by the subject marker ga. Although both sentences contain two verbs, and the noun is not the subject of the matrix clause, when case marker information is utilized, the first noun in the object relativization condition is more likely to be wrongly interpreted as the subject of the matrix clause than the first noun in the subject relativization.

Studies based on the Competition Model predict a language-specific difference in the choice of wrong answers. Su (2001) has found that English speakers tend to interpret the first noun phrase in a sentence as the subject of the sentence. If such a processing strategy transfers, then we would expect English speakers to choose the “wrong subject answer,” in which first noun phrases are mistakenly interpreted as the matrix subject, more than other speaker groups. If the English speakers use the case information, then they would wrongly interpret ga-marked argument of the relative clause, the subject of the object relativization condition, as the subject of the matrix sentence more than the o-marked argument of the subject relativization condition. On the other hand, if they do not fully utilize the case information, such difference by case may not be revealed.

6.2 Method
6.2.1 Participants
The participants in Experiment 2 were the same subjects as those in Experiment 1.

6.2.2 Materials
Two sets of six sentences each were created, one with an object relativization modifying a matrix subject noun and another with a subject relativization modifying a matrix subject noun. Each subject saw half the sets with the object relativization condition and the other half with the subject relativization condition. The six sentences were interspersed with thirty-six filler sentences in the experimental questionnaire. Each sentence was followed by a comprehension question with multiple choice answers, which was designed to reveal how the subjects interpreted the sentence. The subjects were to choose from a set of a correct answer, a wrong subject answer, and a wrong answer. In order to avoid biasing the choice of answers by their order of appearance, the answers were rotated and randomized. Thus three answers appeared at different positions in each question.

6.2.3 Task
The participants read sentences given in the same booklet as Experiment 1. They were given 25 seconds to read each sentence and circle the most appropriate answer from the three choices. Once they chose an answer, subjects were not allowed to go back and change it.

6.3 Results
The proportion of correct answers is shown in Figure 1. A 2x3 ANOVA on the type of relativization and language type revealed that there was a main effect of language type, F(2, 70)=15.34, p< .01. No main effect of the type of relativization was observed. Fisher’s PLSD post-hoc test revealed that overall, Korean speakers comprehended most accurately, followed by Chinese speakers, and then by English speakers (p <.05). Within each speaker group, Chinese speakers comprehended object relative clauses more accurately than subject relative clauses, F(2, 22)=8.88, p<.05. Within groups of Korean and English, no difference was observed between the type of relativizations.

Next, the proportion of wrong subject answers, that is, answers where the participant interpreted the first noun phrase in a sentence to be the subject of the matrix sentence, is shown in Figure 2. There was a main effect of language, F(2, 70) = 14.99, p< .01. Fisher's PLSD post-hoc test revealed that among the three groups, speakers of English interpreted the first noun as the matrix subject most frequently among the three speaker groups (p<.05). There was also a main effect of relativization, F(2, 70)=4.48, p<.05. Rather surprisingly, the accusative marked noun phrase in the subject relativization condition was more frequently interpreted as the main subject than the nominative marked noun phrase in the object relativization condition.
Figure 1. Proportion of correct answers by language and type of relative clause in Experiment 2

Figure 2. Proportion of interpreting the first noun phrase as the matrix subject in Experiment 2
No Korean speakers chose the first noun as a matrix subject, either in subject or object relativization sentences. Within each language group, no significant difference was observed between the two types of relativization.

6.4 Discussion
The results replicated the transfer of some of the processing strategies found in studies based on the Competition Model. English speakers, who are known to utilize word-position information, tended to interpret the first noun phrase as a matrix subject most frequently among the three languages, nearly thirty percent of the time.

Crucially, the accuracy of comprehension among the three language groups was ranked in the order of the sentence processing proximity. Speakers of Korean, the language that shares the most processing-related features with Japanese, understood the target sentences most accurately, while speakers of English, the language that shares the least processing-related features with Japanese, made the most mistakes in comprehension. Considering the fact that the students of all three groups received almost identical amounts of instruction using the same methods, the differences among the results of these groups may be best understood as a reflection of the processing proximity.

The pattern of incorrectly interpreting the first noun phrase as the subject of the matrix sentence was also ranked in the order of the proximity of the languages to Japanese. Korean speakers performed best; no misinterpretation of the first noun phrase as the subject was made. The Chinese speakers do not have case markers in their language, but the structure of the relative clause that they read in the current experiment is similar to their structure, a fact that may have given an advantage to Chinese speakers over English speakers in interpreting the sentences accurately. Once Chinese speakers realized that the sentence starts with a relative clause, they may be able to reanalyze, as the structure of the relative clause in Chinese is similar to Japanese. Unlike in Experiment 1, English speakers did not fully utilize the case marking information in comprehending center-embedded sentences. Recall that in Experiment 1, the first noun phrases in noncanonical sentences were marked accusative. Despite the noncanonical order, they identified the subject and object with eighty-three percent accuracy in Experiment 1, showing that case marker information was constantly utilized. In Experiment 2, in contrast, English speakers understood the first accusative-marked noun phrase in embedded sentences as a subject thirty-three percent of the time, although the statistical analysis did not reach significance \((F(1, 11)=1.45, p > .05)\). This suggests that
English speakers did not effectively use the case marker information of the first noun when reading the more complex sentences in Experiment 2.

The results of Experiment 2 indicate that the effects of sentence processing proximity and the transfer of processing cues are not completely unrelated to the structural complexity of the sentences that readers read. Rather, such effects may manifest in sentences that are more demanding in terms of processing resources. We now turn to sentences that demand more processing resources than those of the previous two experiments to further explore this point.

7 Experiment 3: Center-embedded sentences

Experiment 3 examined the comprehension of center-embedded sentences by the same three groups of speakers. A sample of experimental sentences is shown in Table 5 below.

There were four conditions: (1) All-animate, Subject relativization, (2) All-animate, Object relativization, (3) Inanimate object, Subject relativization, and (4) Inanimate object, Object relativization. All conditions were sentences with a matrix transitive verb, a matrix object modified by the relative clause, and a transitive verb in a relative clause. In two Subject relativization conditions (All-animate, Subject relativization and Inanimate object, Subject relativization), the subject of the relative clause was relativized. In two Object relativization conditions (All-animate, Object relativization and Inanimate object, Object relativization), the object of the relative clause was relativized. As a consequence of differences in relativization in the matrix object, the beginnings of sentences in All-animate, Subject condition and Inanimate object, Subject relativization condition are temporarily indistinguishable from the simplex sentence, in which the nominative marked matrix subject and accusative marked object within a relative clause appear as a subject and an object of a same sentence. On the other hand, in two Object relativization conditions, the first two NPs are both nominative marked, indicating they are both candidates for a subject of different clause.

In two All-animate conditions, all participants of the matrix and subordinate clauses were human. In two Inanimate object conditions, the matrix subject and the subject of the relative clause were human, but the object of the relative clause was an inanimate object in order to have some semantic contrast between the All-animate conditions. Once again we will examine the effects of semantic cues and compare among different native speaker groups.
Table 5. Sample Sentences with multiple-choice answers representing each condition for Experiment 3

<table>
<thead>
<tr>
<th>Subject relativization (ga-o order) and answers</th>
<th>All Animate</th>
<th>Inanimate object</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-nom [[e A-acc Vt][A]-acc Vt</td>
<td>A-nom [[e I-acc Vt][A]-acc Vt</td>
<td></td>
</tr>
<tr>
<td>Onnnanohito-ga [[Tanakasan-o Woman-NOM Mr. Tanaka-ACC matteiru] [otokohonito]-o yobimasita. is waiting man-ACC called</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“The woman called the man who is waiting for Mr. Tanaka.” correct: The woman called the man. garden path: The woman is waiting for Mr. Tanaka. wrong: Mr. Tanaka is waiting for the man.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensee-ga [[otya-o ireta] Teacher-NOM tea-ACC brew [gakusee]-o mimasita. student-ACC saw</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“The teacher saw the student who brewed the tea.” correct: The teacher saw the student. garden path: The teacher brewed hot tea. wrong: The student saw the teacher.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Object relativization (ga-ga order) and answers</td>
<td>A-nom [[A-nom e Vt][A]-acc Vt</td>
<td>A-nom [[A-nom e Vt][I]-acc Vt</td>
</tr>
<tr>
<td>A-nom [[A-nom e Vt][A]-acc Vt</td>
<td>A-nom [[A-nom e Vt][I]-acc Vt</td>
<td></td>
</tr>
<tr>
<td>Onnnanohito-ga [[Tanakasan-ga Woman-NOM Mr. Tanaka-NOM matteiru] [Otokohonito]-o yobimasita. is waiting man-ACC called</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“The woman called the man that Mr. Tanaka is waiting for.” correct: The woman called the man. garden path (control): The woman is waiting for Mr. Tanaka. wrong: The man is waiting for Mr. Tanaka.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensee-ga [[gakusee-ga ireta] Teacher-NOM student-NOM brewed [otya]-o mimasita. tea-ACC saw</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“The teacher saw the tea that the student brewed.” correct: The teacher saw the tea. garden path (control): The teacher brewed hot tea. wrong: The student saw the teacher.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
As with the conditions in Experiment 2, the correct interpretation of the conditions in Experiment 3 involves (1) identifying the structure as a sentence with a relative clause, (2) identifying the relative head and the relative clause it is modified by, (3) identifying that the first verb is part of a relative clause, not a matrix verb, and (4) correctly assigning the thematic roles that the two verbs assign. In addition, most of these operations must be conducted while the processing of the matrix clause is left uncompleted. Unlike the conditions in Experiment 2, where the embedded clause (relative clause) is completed before the matrix subject appears, the center-embedded conditions in Experiment 3 require readers to compute both matrix and subordinate clauses simultaneously, which demands more processing resources than the sentences in Experiment 2. Successful comprehension is measured by a comprehension question given after each sentence. The questions are multiple choice with three answers to choose from: correct answers, garden-path answers, and wrong answers. The order of the types of answers was randomized across sentences. These comprehension questions should reveal how the subjects interpreted the different types of sentences.

The structures in this experiment allow another measure of comprehension that reflects an interesting processing phenomenon: minimal attachment and garden-path (Frazier and Fodor, 1978). In previous psycholinguistic research, it has been shown that native speakers of Japanese initially interpret the first few words in sentences of this type as a simplex clause, making minimal attachment in building a syntactic structure (e.g., Kamide and Mitchell, 1999; Yamashita, 1994, 1997). Upon reading disambiguating information, they are faced with reanalysis, that is, they must correct the first syntactic interpretation in an effort to reach the correct interpretation. The process of initial misanalysis and its reanalysis is called garden-path. Native Japanese speakers start interpreting sentences as a simplex clause and garden-path upon encountering the relative head and further information from the matrix verb (e.g., Kamide and Mitchell, 1999; Yamashita, Stowe, and Nakayama, 1993; Yamashita, 1997, 2000). While native speakers are successful most of the time in revising the initial misanalysis, added difficulty such as the length between the relevant information (e.g., Ferreira and Henderson, 1995) sometimes causes problems in reanalysis even among native speakers. Such initial misanalysis and subsequent reanalysis often result in increased reading time or a sense of difficulty in comprehension.

Garden path answers also reveal information about the use of case markers, a foreign cue for English and Chinese speakers. Notice that in Subject relativization sentences, the first two NPs are marked by nominative and accusative markers, respectively. These are more likely to seem like the beginning of a simplex clause that ends with a transitive verb. Thus it is easy to garden-path in these sentences if case marking
information is used. In contrast, the same first two NPs in object relativization sentences are both marked as nominative, which can be an effective indicator for center-embedding, that is, signaling that there are both matrix and subordinate clauses in the sentence. If the case marking information is used by readers, then the garden-path interpretation in the object relativization condition should not be as frequent as in the subject relativization condition. Whether the case marking information is used by English and Chinese speakers to avoid garden-path answers, in contrast to Korean speakers, will reveal the use of foreign cues in processing sentences with a heavy processing load.

7.1 Hypothesis and Predictions
If speakers in all three groups used knowledge about relative clause structure and case marking in Japanese and processed the structures following Japanese sentence processing strategies, we would expect no difference in the proportion of correct answers among speaker groups. On the other hand, if the effects of processing proximity manifest, then the proportion of correct interpretations should reflect the order of processing-related language proximity: Korean speakers would comprehend the sentences best, followed by Chinese speakers, and then English speakers.

Furthermore, if a similar process to that followed by L1 learners of misanalysis and reanalysis occurs with L2 readers in the current experiment, then their initial interpretation would be (b), the garden path answer. While some may recover from it, as in the case of native speakers, L2 readers, with their more limited skills, may never recover and choose answer (b) as their final answer. Alternatively, they may simply run out of processing resources, thus failing to capture the full and accurate semantic representation of the sentence, and choose an answer in keeping with the portion that they can make sense of. Either way, garden-path answers reflect readers’ attempts at and partial successes in comprehension. Finally, comparison between garden-path answers with two types of relativization reveals whether case marking information is utilized to assist comprehension. We would expect that if L2 readers use the case information aggressively, they will be able to avoid garden-path answers in object relativization, where the first two arguments are nominative marked in comparison to the subject relativization conditions.

7.2 Method
7.2.1 Participants
The participants in Experiment 3 were the same as those in Experiments 1 and 2.
7.2.2 Materials
Six semantically unrelated sentences were created for each of the following four conditions: All-animate, Subject relativization; All-animate, Object relativization; Inanimate object, Subject relativization; and Inanimate object, Object relativization. Each subject saw half six sentences from each set. The twelve sentences were interspersed with thirty-six filler sentences in the experimental questionnaire. Each sentence was followed by a comprehension question with multiple choice answers, which was designed to reveal how the subjects interpreted the sentence. The answers from which the subjects were to choose were a set of a correct answer, a garden-path answer, and a wrong answer. In order to avoid biasing the choice of answers by their order of appearance, the answers were rotated and randomized. Thus the three answers appeared at different positions in each question.

7.2.3 Task
The task was the same as that in Experiment 2.

7.3 Results
The proportion of correct answers is shown in Figure 3. A 2x2x3 ANOVA on animacy, type of relativization, and language type revealed that there was a main effect of language, F(2, 70)=7.937, p < .05. Fisher's PLSD post-hoc test revealed that Korean speakers chose the correct answer more frequently than either English or Chinese speakers (p < .05). There was no difference between English and Chinese speakers in the proportion of correct answers (p > .05). No main effect of relativization type (Subject or Object relativization) was observed, F(1, 35)=1.23, p > .05. No interaction was observed between language type and type of relativization, F(2, 70)=1.71, p > .05. Within each language, no difference between the two types of relativizations was observed (p > .05).

Figure 4 shows the proportion of correct answers according to language and animacy. A main effect of animacy was observed: all-animate sentences were comprehended less accurately than animate-inanimate sentences, F(1, 35)=5.89, p < .05. No interaction was observed between the language type and animacy, F(2, 70)=.189, p > .05, nor between language and the type of relativization F(2, 70)=1.71, p > .05. No three-way interaction was significant. Within a language, no main effect of relativization was observed in English (F(1, 11)=2.42, p > .05) or Korean (F(1, 11)=0.85, p > .05). Interestingly, in contrast, Chinese speakers comprehended the subject relativization better than the object relativization, F(1, 11)=10.41, p < .05. Chinese speakers also comprehended inanimate-object conditions better than all-animate conditions F(1, 11)=8.49, p < .05.
Figure 3. Proportion of correct interpretation by languages and type of relativization in Experiment 3

Figure 4. Proportion of correct answers by language and animacy in Experiment 3
Next, the proportion of garden-path answers was analyzed. As shown in Figure 5, there was a main effect of language, $F(2, 70)=93.90, p<.05$. Fisher's PLSD post-hoc analysis revealed that English speakers chose garden-path answers most frequently; they chose the answer significantly more often than Korean speakers ($p<.05$), followed by the Chinese speakers. Korean speakers chose garden-path answers least frequently ($p<.05$). A main effect of animacy was also observed, $F(2, 70)=56.22, p<.05$. The interaction between language and animacy was significant, $F(2, 70)=89.43, p<.05$. Within each language, Chinese speakers comprehended inanimate-object conditions significantly better than all-animate conditions $F(1,11)=21.65, p<.01$. No effects of animacy was observed in English ($F(1,11)=.038, p>.05$) nor in Korean ($F(1,11)=.21, p>.05$).

![Figure 5](image)

**Figure 5. Proportion of garden path interpretation by language and type of relativization in Experiment 3**

### 7.4 Discussion

Experiment 3 showed that once again Korean speakers comprehended the sentences most accurately among the three speaker groups. English speakers comprehended the sentences less accurately than Korean speakers. Furthermore, English speakers chose garden-path answers more frequently than either Korean or Chinese speakers. Within each language, the differences in relativization and therefore the effect of case marking cues did not affect the frequency of garden-path answers very much. Although it is a null result, it is noteworthy that English speakers chose garden-path answers slightly
more often when the marking was nominative-nominative, than when it was nominative-accusative. In other words, they chose the simplex sentence analysis more when the cues unambiguously signaled that there are two clauses (non-garden-path analysis). This further demonstrates that English speakers did not utilize case-marking information in Experiment 3. Such neglect of case marking information by English speakers in this experiment thus replicates their response in Experiment 2. Note that English speakers used the case marking information well in Experiment 1, and not so in Experiments 2 and 3. We will revisit this issue in the general discussion.

Overall, inanimate object sentences were comprehended better than all-animate sentences, suggesting that semantic information in addition to syntactic information facilitates comprehension. Chinese speakers were once again affected by the absence of semantic cues in all-animate conditions, replicating the results of Experiments 1 and 2 and the findings in studies using the Competition Model.

8 General discussion

The current study investigated the comprehension accuracy of L2 for beginning learners based on the processing proximity between L1 and L2. The experiments reveal evidence in support of two hypotheses. One is the transfer of processing cues, as had been reported in the Competition Model studies. The study contributes in understanding the processes that learners go through by using a paradigm significantly different from the traditional Competition Model studies; despite the difference in the modality, the current study shows that Chinese speakers were most affected by the presence or absence of animacy cues, replicating the findings in the studies of Competition Models. It also shows that English speakers showed a tendency to find the subject of a sentence based on word position.

Second, the three experiments demonstrate an interaction between structural complexity and sentence processing strategy proximity. Speakers of Korean, the language among the three closest to Japanese, consistently performed best regardless of the complexity of the experimental sentences in three experiments. In contrast, speakers of English, most distant from the target language among the three groups, performed least accurately overall, and their comprehension accuracy declined as the sentence complexity increased in Experiments 2 and 3, in comparison to Experiment 1. Chinese

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3 The accuracy rate by English speaker in Experiment 3 was slightly better than that in Experiment 2. This may suggest that factors other than the complexity of sentences and their processing resource demands. One factor that may have affected English speakers in Experiment 2 is their tendency to interpret first noun in a sentence as the subject of the matrix.
speakers overall fell between two speaker groups. These results are despite the fact that all these speaker groups started learning Japanese at the same time and went through the same practices in virtually identical manners. Thus, the study suggests that there are indeed effects of proximity in the learning of L2 by beginning level learners.

Finding support for the second hypothesis raises a further question: what it means for speakers of different languages to have difference in comprehension skills. One possibility is that comprehending sentences of a language that is distant in processing proximity from one’s native language may consume more processing resources in comparison to processing a language that is closer, causing disadvantages in comprehending sentences which tends to manifest when the sentence complexity increases. Recall in Experiment 1 that comprehension accuracy and the use of case markers by all three language groups were compatible in the reading of simplex sentences. It is precisely when the sentences became complex and demanding in the use of processing resources (in Experiments 2 and 3) that the processing proximity showed dramatically different results in comprehension. The decrease of the utilization of case markers, as well as the decrease of comprehension accuracy, became more evident among English speakers, followed by Chinese speakers, as sentence complexity increased in Experiments 2 and 3. Furthermore English speakers made garden-path interpretations from which they failed to recover more often than either Chinese or Korean speakers in Experiment 3. Such a decline in performance is not arbitrary but is congruent with the symptoms of readers exhausting the processing resources. In other words, the results suggest that poor comprehension by English speakers is not due to a lack of grammatical knowledge but to the demands of its actual use in sentence processing. While English speakers were able to compute Japanese simplex sentences using case marking information and the knowledge of noncanonical word-order, they were unable to utilize all the grammatical information necessary to compute complex sentences in many cases because they ran out of processing resources. Assuming that there is no difference in processing capability (working memory) among speakers of the three languages, one possible source of difference in performance is language proximity. For English learners to process Japanese sentences might require more processing resources than for Korean speakers to do so.

Such a claim is not unreasonable. Researchers have discussed a link between processing resources represented by working memory and language learning capability (e.g., Ellis and Sinclair, 1996; Miyake and Feldman, 1998). If the speaker’s L1 grammar sentence. Further investigation of the interaction between the processing cues and sentence complexity is necessary.
is activated when they read a foreign language at the beginning level, and then there is always competition, or at least checking, between the two grammars (MacWhinney, 1992). The process is easier or takes less effort if the speaker knows, by previous successful experiences, that the two grammars share many similarities. Or as recent psycholinguistic studies suggest, the speakers may be using the same processing resource or even the knowledge of syntactic structure in L1, when the L2 syntactic structure that they read is the same (the “shared-syntax hypothesis”), as suggested by fMRI study by Jeong, Sugiura, Sassa, Haji, Usui, Taira, Horie, Sato and Kawashima (2007). Then it is possible that L1 learners that read a structure in L2 that also exists in L1 have less processing demands than those that read a structure that do not exist in L1.

In contrast, until the stage when speakers operate in the target language alone, speakers of distant languages cannot rely on their L1 knowledge. Rather, they must always compete with their L1 grammar and resist applying it when comprehending the target language. Such operations may demand higher processing loads in comparison to speakers of languages close to the target, resulting in inaccuracy in comprehension, comprehension breakdown, or being unable to pay attention to foreign cues, which must be consciously utilized in order to comprehend the target language.

Additional support for the claim comes from a study conducted in a different paradigm. Takano and Noda (1995) compared the accuracy rate of simple addition between speakers of languages of different proximity to the target language. German and Japanese speakers were assigned an additional task while they listened to a question in their native language and in the target language (English). German is closer linguistically, according to Takano and Noda, than Japanese. Their results demonstrated that, despite the similarity in foreign language training, Japanese speakers’ accuracy in the addition task declined significantly more than German speakers when they listened to the yes/no questions in English and answered. The same results were obtained when English and Korean speakers were tested with questions in Japanese. This demonstrates that computation skills are impeded by an assigned parallel linguistic task, and such impediment is greater when the foreign language is distant from the target language. While the finding in Takano and Noda further supports our claim, it is difficult to closely control the participants’ content and conditions of learning history by simply the number of years of study. Testing students who were all taught the language in the same way, as in the current study, offers additional support to their claim.

For the future consideration, it is important to reemphasize that the grammatical characteristics that were considered here do not exhaust all that affect processing L2. Those that are examined in this study are exemplary when comparisons are made between Japanese and Korean, Chinese and English. Other factors that could play a role
include, but not limited to, grammatical features such as the use of articles, overt marking of finiteness, and existence of phonologically null pronouns. It is hoped that these will be examined in future studies.

Furthermore for future study, a different paradigm needs to replicate the effects by the proximity. Current reading study used the most natural writing style for the participants – the L2 learners that studied Japanese for approximately 160 hours. The stimuli used Kanji that have been frequently used by all students in the Japanese class, regardless of their L1. However, Korean and Chinese students may have some advantages in reading experiments as in the current study because similar sets of characters, if not exactly the same, are also used in their native language. Although the sound attached to the Kanji are different, Korean and Chinese students may have had an advantage in the recognition of the meaning. One way to eliminate such factor would be to test these structures in an auditory-based study.

8.1 Pedagogical implications
The current study has pedagogical implications for the order in which the grammatical structures are taught, regardless of a learner's native language. One is the order in which grammatical information is introduced. The fact that simple structures demand less processing resources than complex structures suggests that grammatical structures that require a lighter processing load should be introduced before those that are more demanding. Experienced teachers and well-designed textbooks have done so for many years, and now it can be argued that such an approach has an advantage of effectively managing processing resources. As a simple structure is mastered and becomes automatic, learners' processing demands become low. Introducing further structures that make use of the former simple structure is a logical order of instruction to avoid overtaxing processing resources. Needless to say, in introducing the more demanding structures, attention should be paid to reducing the amount of irrelevant information that adversely affects the processing load, such as long modifiers on arguments or low-frequency/ newly introduced words whose processing themselves consume processing resources.

The current study is the first to suggest a relation between processing demands and the distance between native and target languages. Needless to say, further investigation is necessary in order to establish a link between processing resources and distance between languages. If, however, comprehending a distant language indeed requires a larger processing load, it is possible that a learner’s second language acquisition is

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4 I thank the anonymous reviewer to bring up this point.
affected considerably by it. When the grammar is first introduced, students whose native language is distant, such as English speakers learning Japanese, may comprehend the structure inaccurately or have more difficulty in retaining instructional information in comparison to learners whose native language is close. Take, for example, the case of learning a relative clause, which has been one of the foci of language acquisition (Izumi, 2003). For English speakers, in comparison to Korean speakers, many concepts must be taught and retained consciously: recognizing the location of the head noun, utilizing the case information to figure out the relations among the participants of the event, and keeping track of where in the matrix clause the relative clause appears. One may easily imagine such effort, at least until it is automatic, involves the use of extra processing resources, sometimes leading to inaccurate comprehension and slow understanding and use of grammatical structures.

While the direct association between language comprehension and production is still under investigation in L1 literature, effects on production may be inferred. Sentence assembly demands that speakers keep track of linguistic information at multiple levels: discourse (keeping the conversational log and updating it), semantic (content of the sentence to be uttered), syntactic (framing the semantic information correctly according to the grammar of the language), and phonological (pronouncing the words correctly). When assembling a syntactic structure that is distant from one’s native language, speed and accuracy in the formation of the structure may be affected.

The current study suggests that if the learner's native language is distant, closer attention should be paid to the order in which structures are taught and the processing load involved. Due to multiple factors, such as classroom size, student demographics, cultural themes, and relevant vocabulary, it may not be possible to follow such a principle all the time. However, the factor of processing resources in students' learning should certainly be worthy of consideration whenever possible in the process of teaching foreign languages.

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References


Appendix A
Stimuli for Experiment 1

All Animate
1A 先生が学生をまっています。
1B 学生が先生がまっています。

2A スミスさんがジョンソンさんをしています。
2B ジョンソンさんをスミスさんがしています。

3A 先生が大学生を見ました。
3B 大学生が先生が見ました。

4A ジョーンズさんがスミスさんをよびました。
4B スミスさんをジョーンズさんがよびました。

5A 男の子が女の子を待っています。
5B 女の子を男の子が待っています。

6A たなかさんがジョーンズさんをしています。
6B ジョンズさんをたなかさんがしています。

Inanimate Object
1A やまださんがおちゃをのみました。
1B おちゃをやまださんがのみました。

2A 学生がテレビをつけました。
2B テレビを学生がつけました。

3A 女の人が新聞をよんでいます。
3B 新聞を女の人がよんでいます。

4A チェンさんが自動車を買います。
4B 自動車をチェンさんが買います。

5A スミスさんが日本語を話します。
5B 日本語をスミスさんが話します。

6A 女の人がきっとを買ってています。
6B きっとを女の人が買ってています。
Appendix B
Stimuli for Experiment 2

A: Subject Relativization, B: Object Relativization
Answers: 1: correct, 2: wrong subject, 3: wrong

1A 先生を見た学生がかえりました。
1. “The student went home.”
2. “The teacher went home.”
3. “The teacher saw the student.”
1B 先生が見た学生がかえりました。
1. “The student went home.”
2. “The teacher went home.”
3. “The student saw the teacher.”

2A 男の人がさがしている女の子がここにいます。
1. “The girl is here.”
2. “The boy is here.”
3. “The boy looked for the girl.”
2B 男の人がさがしている女の子がここにいます。
1. “The girl is here.”
2. “The boy is here.”
3. “The girl looked for the boy.”

3A 田中さんをよんだ男の人が来ました。
1. “The man came.”
2. “Mr. Tanaka came.”
3. “Mr. Tanaka called the man.”
3B 田中さんがよんだ男の人が来ました。
1. “The man came.”
2. “Mr. Tanaka came.”
3. “The man called Mr. Tanaka.”

4A やまとさんを知っている学生がかえりました。
1. “The student went home.”
2. “Mr. Yamamoto went home.”
3. “Mr. Yamamoto knows a student.”
4B  やまもとさんが知っている学生がかえりました。
1. “The student went home.”
2. “Mr. Yamamoto went home.”
3. “The student knows Mr. Yamamoto.”

5A  女の子をまっている男の人が来ました。
1. “The man came.”
2. “The girl came.”
5B  女の子がまっている男の人が来ました。
1. “The man came.”
2. “The girl came.”

6A  メアリーさんを見た先生が話しています。
1. “The teacher is talking.”
2. “Mary is talking.”
3. “Mary saw the teacher.”
6B  メアリーさんが見た先生が話しています。
1. “The teacher is talking.”
2. “Mary is talking.”
3. “The teacher saw Mary.”
Appendix C
Stimuli for Experiment 3

All Animate
A: Subject relativization (ga-o order) and answers; B: Object relativization (ga-ga order) and answers
Answers: 1: correct, 2: garden path (control condition in B), 3: wrong

1A 女の人がたなかさんが待っている男の人がよびました。
1. The woman called the man.
2. The woman is waiting for Mr. Tanaka.
3. Mr. Tanaka is waiting for the man.
1B 女の人がたなかさんが待っている男の人がよびました。
1. The woman called the man.
2. The woman is waiting for Mr. Tanaka.
3. The man is waiting for Mr. Tanaka.

2A キムさんが学生をよんだ先生を見ました。
1. Ms. Kim saw the teacher.
2. Ms. Kim called the student.
3. The student called the teacher.
2B キムさんが学生をよんだ先生を見ました。
1. Ms. Kim saw the teacher.
2. Ms. Kim called the student.
3. The teacher called the student.

3A よしむらさんが男の子を見ている女の人が待っています。
1. Mr. Yoshimura is waiting for the woman.
2. Mr. Yoshimura is looking at the boy.
3. The boy is looking at the woman.
3B よしむらさんが男の子を見ている女の人が待っています。
1. Mr. Yoshimura is waiting for the woman.
2. Mr. Yoshimura is looking at the boy.
3. The woman is looking at the boy.
4A 先生が女のを見たこどもをよんでいます。
1. The teacher is calling the child.
2. The teacher saw the woman.
3. The woman saw the child.
4B 先生が女の見たこどもをよんでいます。
1. The teacher is calling the child.
2. The teacher saw the woman.
3. The child saw the woman.

5A よしださんがスミさんが知っている学生をさがしています。
1. Mr. Yoshida is looking for the student.
2. Mr. Yoshida knows Mr. Smith.
3. Mr. Smith knows the student.
5B よしださんがスミさんが知っている学生をさがしています。
1. Mr. Yoshida is looking for the student.
2. Mr. Yoshida knows Mr. Smith.
3. The student knows Mr. Smith.

6A なかむらさんが学生を待った女の子を知っています。
1. Ms. Nakamura knows the girl.
3. The student waited for the girl.
6B なかむらさんが学生を待った女の子を知っています。
1. Ms. Nakamura knows the girl.
3. The girl waited for the student.

Inanimate object
A:Subject relativization (ga-o order) and answers; B: Object relativization (ga-ga order) and answers
Answers: 1: correct, 2:garden path (control condition in B), 3:wrong

1A 先生がおちゃをいった学を見ました。
1. “The teacher saw the student.”
2. “The teacher brew hot tea.”
3. “The student saw the teacher.”
1B 先生が学生がいれたおちゃを見ました。
1. “The teacher saw the tea.”
2. “The teacher brew hot tea.”
3. “The student saw the teacher.”

2A スミスさんがピザを食べた女の子をしています。
1. “Ms. Smith knows the girl.”
2. “Ms. Smith ate some pizza.”

2B スミスさんが女の子が食べたピザをしています。
1. “Ms. Smith knows the pizza.”
2. “Ms. Smith ate some pizza.”

3A やまもとさんがコーヒーを飲んでいる学生を見ています。
1. Mr. Yamamoto is looking at the student.”
2. Mr. Yamamoto is drinking coffee.”
3. The student is looking at Mr. Yamamoto.”

3B やまもとさんが学生が飲んでいるコーヒーを見ています。
1. Mr. Yamamoto is looking at the coffee.
2. Mr. Yamamoto is drinking coffee.
3. The student is looking at Mr. Yamamoto.

4A 女の子が本をかりた学生をしらべています。
1. The girl is investigating the student.
2. The girl borrowed a book.
3. The student is investigating the girl.

4B 女の子が学生がかりた本をしらべています。
1. The girl is investigating the book.
2. The girl borrowed the book.
3. The student is investigating the girl.

5A 男の人がしゃしんをとった先生を待っています。
1. The man is waiting for the teacher.
2. The man took the picture.
3. The teacher is waiting for the man.
5B 男の人が先生がとったしゃしんを待っています。
1. The man is waiting for the picture.
2. The man took the picture.
3. The teacher is waiting for the man.

6A ジョンソンさんがしゅくだいをした男の子を見ました。
1. Ms. Johnson saw the boy.
2. Ms. Johnson did her homework.
3. The boy saw Ms. Johnson.

6B ジョンソンさんが男の子がしたしゅくだいを見ました。
1. Ms. Johnson saw the homework.
2. Ms. Johnson did her homework.
3. The boy saw Ms. Johnson.